

A collage of images showing children interacting with pets. In the foreground, a girl in a blue shirt holds a tabby cat. To her left, a boy in a purple and white striped shirt stands next to a large brown dog. In the background, other children are playing with dogs on a grassy lawn.

Guidelines for Veterinarians:

Prevention of Zoonotic Transmission of
ASCARIDS AND HOOKWORMS
of Dogs and Cats





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Ascarids and Hookworms

Ascarids (*Toxocara canis*, *T. cati*) and hookworms (*Ancylostoma spp.*) are common intestinal parasites of dogs and cats (referred to here as pets). Not only can ascarids and hookworms cause disease in their respective hosts, they are also well-known causes of larva migrans syndromes in humans, especially children. While ascarids and hookworms are most commonly diagnosed in puppies and kittens, infections can occur in dogs and cats of all ages. Dogs can also become infected with *Baylisascaris procyonis*, the common raccoon ascarid, which can cause serious disease in other animals and humans.¹

Ascarids Because of the occurrence of both transplacental and transmammary transmission of *T. canis*, puppies are usually born with or acquire ascarid infections early in life.² Kittens do not become infected in utero but, like puppies, can acquire ascarids (*T. cati*) through the queen's milk.³ The tissue-migrating and early intestinal stages of these worms may cause severe, sometimes life-threatening, disease in the first few weeks of life. Patent intestinal infections can develop within the first 2½–3 weeks of life. Left untreated, this infection can lead to widespread contamination of the environment with infective eggs.

Hookworms Both puppies and kittens acquire hookworm infections (*A. caninum*, *A. braziliense*, and *A. tubaeforme*) through ingestion of or skin penetration by infective larvae or from infective larvae passed in their dam's milk (*A. caninum*).² Hookworms suck large amounts of blood from their hosts; while infected animals may look healthy in the first week of life, they can develop a rapidly severe, often fatal, anemia.⁴ Patent intestinal infections can occur as early as 2– (dogs) to 3– (cats) weeks of age, leading to environmental contamination with infective larvae.^{5,6}

The prevalence of these infections varies with climatic conditions; however, they are present in all parts of the United States and must be viewed as a potential public health hazard.^{6,9}

Zoonotic Transmission and Human Disease



The growing popularity of dogs and cats in the United States, together with high rates of ascarid and hookworm infections, has resulted in widespread contamination of the soil with infective eggs and larvae.

Epidemiologic studies have implicated the presence of dogs, particularly puppies, in a household, and pica (dirt eating) as the principal risk factors for human disease. Children's play habits and their attraction to pets put them at higher risk for infection than adults.

Humans become infected with ascarids (*Toxocara spp.*, *Baylisascaris spp.*) through ingestion of infective eggs in the environment. When a human ingests infective eggs, the eggs hatch and release larvae that can migrate anywhere in the body, a condition known as visceral larva migrans. The signs and symptoms seen in humans are determined by the tissues or organs damaged during larval migration. Organs commonly affected are the eye, brain, liver, and lung, where infections can cause permanent visual, neurologic, or other tissue damage. The common dog ascarid, *T. canis*, has long been recognized as a cause of larva migrans syndromes in children. The cat ascarid, *T. cati*, can also cause disease in humans, although for reasons partly related to the defecation habits of cats, it does so less frequently. The raccoon ascarid, *B. procyonis*, is increasingly being recognized as a cause of human disease.¹⁰

Humans can become infected with hookworms through ingestion of infective larvae or through direct penetration of the skin.⁷ When infective larvae penetrate the skin, they undergo a prolonged migration that causes a condition known as cutaneous larva migrans. These larval migrations are characterized by the appearance of progressive, intensely pruritic, linear eruptive lesions, which are usually more extensive with *A. braziliense* infections. *A. caninum* larvae may also penetrate into deeper tissues and induce symptoms of visceral larva migrans or migrate to the intestine and induce an eosinophilic enteritis.^{11,12}

The Public Health Problem



Larva migrans syndromes are not reportable in the United States, so the actual number of human cases is unknown. However, many human cases continue to be diagnosed and a recent national survey of shelters revealed that almost 36% of dogs nationwide and 52% of dogs from southeastern states harbored helminths capable of causing human disease.¹³ Every year at least 3,000–4,000 serum specimens from patients with presumptive diagnoses of toxocariasis

are sent to the Centers for Disease Control and Prevention (CDC), state public health laboratories, or private laboratories for serodiagnostic confirmation.¹⁴ Zoonotic hookworm infections are more geographically restricted than toxocariasis, with most cutaneous larva migrans and other hookworm-associated syndromes diagnosed in southeastern and Gulf Coast states. Persons likely to come in contact with larvae-contaminated soil include electricians, plumbers, and other workers who crawl beneath raised buildings and sunbathers who recline on larvae-contaminated sand, as well as children who play in contaminated areas. While most hookworm infections are self-limiting, massive infections can lead to infection of deeper tissues.¹⁵

Veterinarians Can Help Prevent Human Disease



Most cases of human ascarid and hookworm infections can be prevented by practicing good personal hygiene, eliminating intestinal parasites from pets through regular deworming, and making potentially contaminated environments, such as unprotected sand boxes, off limits to children.^{9,10,14} It is also important to clean up pet feces on a regular basis to remove potentially infective eggs before they become disseminated in the environment via rain, insects, or

the active migration of the larvae.¹⁶ Hookworm eggs can develop into infective stage larvae in the soil in as little as 5 days and ascarid eggs within 2 weeks, depending on temperature and humidity.⁴ To illustrate the extent of environmental contamination that can occur as the result of one infected puppy, a single female ascarid can produce more than 100,000 eggs/day, resulting in millions of potentially infective ascarid eggs per day spread throughout the area the puppy is allowed to roam.¹⁰ Once the eggs become infective, they can remain infective in the environment for years.^{4,10}

Most pet owners do not know that their pets may carry worms capable of infecting people. Therefore, practicing veterinarians can provide an important public service by recommending regular fecal examinations, providing well-timed anthelmintic treatments, counseling clients on potential public health hazards, and advising them on any precautionary measures that may be taken. Veterinarians are in an ideal position to provide pet owners with this service because of their access to the pet-owning public, their knowledge and training, and their role in the human-animal bond.^{17,18}

Preventive Anthelmintic Treatment



Because puppies, kittens, and pregnant and nursing animals are at highest risk for these infections, and therefore responsible for most of the environmental contamination and human disease, anthelmintic treatments are most effective when they are initiated early and targeted at these populations.^{4,15}

While it has long been recognized that transplacental and transmammary infection of ascarids and hookworms

could be prevented through prophylactic treatment of pregnant dogs, no drugs are currently approved for this use. However, the effectiveness of this approach with different drugs approved for parasite control in dogs has been well documented. Daily treatment of pregnant dogs with fenbendazole from the 40th day of gestation through the 14th day of lactation has been shown to inhibit *T. canis* larvae in tissues, thereby preventing or greatly reducing the incidence of infection in puppies.¹⁹ Alternatively, studies have shown that treatment with ivermectin on day 0, 30, and 60 of gestation and 10 days post whelping reduced the adult *T. canis* worm burden in pups by 100% and prevented the shedding of eggs.²⁰ In yet another study, treatment with selamectin at 10 and 40 days both before and after parturition was effective in reducing *T. canis* fecal egg counts in both pups and their dams and adult worms in the pups.²¹

If the mother did not receive prophylactic treatment, puppies and kittens must be treated early and repeatedly in order to prevent patent infections.²² In areas where both ascarids and hookworms are common, begin treating both puppies and their mothers with an age-appropriate anthelmintic at 2, 4, 6, and 8 weeks of age. Some experts recommend extending this treatment to 12 weeks and then treating monthly until the pet is 6 months old. To treat for ascarids alone, begin treatment by 2½–3 weeks and treat every 2 weeks for at least three additional treatments. Because prenatal infection does not occur in kittens, preventive treatment should begin at 3 weeks of age and be repeated at 5, 7, and 9 weeks. Nursing dogs and queens should be treated concurrently with their

offspring because they often develop patent infections along with their young.

Because most puppies and kittens are not routinely brought to a veterinarian before 6-8 weeks of age, they will already have patent infections and be actively contaminating the environment. For this reason, it is important to reach out to clients who have pregnant or newly born animals at home and provide these animals with early prophylactic treatment for intestinal parasites. Early identification of these high-risk animals will provide the veterinarian with the opportunity to educate the owners on the public health risks, provide them with an appropriate anthelmintic, and advise them on how and when to administer it to their pets at home. This approach to treatment is justified by the frequency with which puppies and kittens acquire intestinal parasites from their mothers and the difficulties that exist in early diagnosis. Because young animals may continuously acquire new infections from nursing and from the environment, they may develop a serious illness or even die before a prenatally or lactogenically acquired infection becomes patent and can be diagnosed by fecal examination.

While intestinal parasites are usually less of a problem in young adult and adult animals, they too can develop patent infections and contaminate the environment. Therefore, they too should be regularly monitored or treated for intestinal parasite infections. While all adult animals are at risk, those that are allowed to roam or spend most of their time outside run a greater risk of becoming infected. There are a variety of anthelmintic drugs available that are safe and effective against ascarids, hookworms, and other intestinal helminths of dogs and cats (Table 1). Mature animals can also be monitored through biannual or yearly diagnostic stool examinations and treated with anthelmintics directed at specific intestinal nematodes. For animals that live in areas where heartworm (*Dirofilaria immitis*) infection is enzootic, many of the heartworm preventives are also effective against intestinal parasites (Table 1).²³

Table 1. Drugs for the treatment of ascarid and hookworm infections in dogs and cats

Name	Route of Administration/ Frequency/Dose	Range of Efficacy	FDA Approved in:	
			Species	Minimum Age/Weight
Diethylcarbamazine citrate ^{1, 10}	Oral 6.6 mg/kg daily	DI	Dog	≥8 weeks
	55–110 mg/kg once; repeat in 10–20 days	A		
Diethylcarbamazine/oxibendazole ^{1, 3, 4, 10}	Oral/daily 6.6 mg/kg DEC 5.0 mg/kg OXI	A, H, W, DI	Dog	≥8 weeks and ≥1 lb
Fenbendazole	Oral/daily for 3 days 50 mg/kg	A, H, W, T	Dog	None
Ivermectin ^{4, 10}	Oral/monthly 24 micrograms/kg	H, DI	Cat	≥6 weeks
Ivermectin/pyrantel pamoate ^{1, 7, 10}	Oral/monthly 6 micrograms/kg IVM 5 mg/kg PYR	A, H, DI	Dog	≥6 weeks
Milbemycin oxime ^{1, 4, 7, 10}	Oral/monthly Dog: 0.5 mg/kg	A, H, W, DI	Dog	≥4 weeks and ≥2 lbs
	Cat: 2.0 mg/kg	A, H, DI	Cat	≥6 weeks and ≥1.5 lbs
Milbemycin oxime/lufenuron ^{1, 4, 7, 10, 11}	Oral/monthly 0.5 mg/kg MO 10 mg/kg LUF	A, H, W, DI	Dog	≥4 weeks and ≥2 lbs
Moxidectin ^{1, 4, 6, 10, 12}	SC/twice yearly 0.17 mg/kg	H, DI	Dog	≥6 months
Piperazine ⁵	Oral/discretionary See label for dose	A	Dog/Cat	≥6 weeks
Pyrantel pamoate ¹⁴	Oral/discretionary 5 mg/kg	A, H	Dog	≥2 weeks
Pyrantel pamoate/praziquantel ^{4, 13}	Oral/discretionary 5 mg/kg PRA 20 mg/kg PYR	A, H, T, D	Cat	≥1 month and ≥1.5 lbs
Pyrantel pamoate/praziquantel/febantel ^{2, 9}	Oral/discretionary 5 mg/kg PYR 5 mg/kg PRA 25 mg/kg FEB	A, H, W, T, D, E	Dog	≥3 weeks and ≥2 lbs
Selamectin ^{1, 4, 7, 8, 10}	Topical/monthly 6 mg/kg	Dog: DI	Dog	≥6 weeks
		Cat: A, H, DI	Cat	

A = ascarids (*Toxocara* and *Toxascaris spp.*); H = hookworm (*Ancylostoma* and *Uncinaria spp.*); W = whipworm (*Trichuris vulpis*); T = Taeniid tapeworms (*Taenia pisiformis*, *Taenia taeniaeformis*, *Taenia spp.*) D = Flea tapeworm (*Dipylidium caninum*); E = *Echinococcus granulosus*, *Echinococcus multilocularis*; DI = *Dirofilaria immitis*.

Contraindications: ¹Not for use in animals with established heartworm infections. ²Do not use in pregnant animals. ³Do not use in dogs with hepatic dysfunction. ⁴Not effective against *Uncinaria*. ⁵Some salts not for use in unweaned animals. ⁶See package insert for injection technique. ⁷Safe in collies at label dose. ⁸Also effective against fleas, flea eggs, ticks, and mites (including ear mites). ⁹Repeat every 21–26 days for control of *Echinococcus multilocularis*. ¹⁰Effective against tissue stage of heartworm larvae. ¹¹Not a flea adulticide — contains an insect growth regulator. ¹²Effective against hookworm larvae and adults at time of injection only. ¹³Consult with veterinarian before using in pregnant animals. ¹⁴Approved for use in lactating dogs (administer 2-3 weeks after parturition).

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Educating and Counseling Pet Owners



Pet owner education regarding intestinal parasites and their effects on the health of both their pets and family members should be included in a well-pet exam. Pet owner education should focus on prevention and include the following:

- ◆ Description of ascarids and hookworms that infect dogs and cats, early signs of illness, and information about when pets are at greatest risk for infection (in utero and when nursing).
- ◆ How ascarids and hookworms cause disease in humans, especially in children whose play habits and attraction to pets put them at increased risk.
- ◆ How prophylactic treatment of pregnant and nursing pets and their offspring can protect their pets from becoming infected, thus preventing them from shedding eggs into and contaminating the environment.
- ◆ The need for regular diagnostic fecal examinations of pups or kittens or prophylactic treatment of older pets.
- ◆ The need for prompt collection and disposal of pet feces, especially in areas where children play, to remove eggs from the environment before they can become a problem.
- ◆ The need to keep children away from areas that may be contaminated with pet feces.



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